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(54) VALVE SYSTEM FOR THE SEQUENTIAL CONTROL OF TWO THROTTLE VALVES

(71) We, AB SVENSKA FLÄKTFABRIKEN, a Swedish Joint Stock Company, of Sickla Allé 1, Nacka, Sweden, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

The invention relates to a valve system and particularly to a valve system in which two throttle valves or dampers are operated sequentially. The system has particular application to an induction-type air-conditioning apparatus.

In a known induction-type air-conditioning apparatus, the apparatus is connected to a duct for ventilating or conditioning air and is provided with a heating device, a cooling device and a so-called by-pass or shunt. There is only a rough adjustment of the temperature of the ventilating air by means of two throttle valves or dampers which are controlled directly or indirectly, for example by means of thermostats, with the result that each throttle valve is controlled in dependence upon the amount of heat required at the time. In such apparatus, ventilating air escaping from nozzles in the apparatus entrains ambient air. The temperature of the ventilating air increases, decreases or remains constant according to whether the path through the heating device, or through the cooling device, or through the by-pass opening to the ventilating-air nozzles is utilised.

Hitherto the attainment of the required throttle valve or damper control has necessitated the use of elaborate, complicated devices which are, moreover, susceptible to faults and only have a limited life.

According to the invention there is provided a valve system comprising a first pivotally-mounted throttle-valve or damper and a second pivotally-mounted throttle-valve or damper each biassed by spring means and/or by weight means to a first limit position, and an actuator for moving said first and second throttle-valves or dampers to a second limit position, in which valve system:

the actuator has a rectilinearly-movable operating member connected to a first drive rod for controlling said first throttle-valve or damper and to a second drive rod for controlling said second throttle-valve or damper whereby when said operating member is in its fully retracted position said first throttle-valve or damper is in its second limit position and said second throttle-valve or damper is in its first limit position, and when said operating member is in its fully extended position said first throttle-valve or damper is in its first limit position and said second throttle-valve damper is in its second limit position; and

the first drive rod has a lost-motion driving connection with a first arm rigid with the first throttle-valve or damper and the second drive rod has a lost-motion driving connection with a second arm rigid with the second throttle-valve or damper, whereby in the movement of said operating member in either direction between its fully retracted and fully extended positions there is an intermediate position of the operating member in which both said first and second throttle-valves or dampers are in said first limit position.

An induction-type air-conditioning apparatus embodying the invention is diagrammatically illustrated, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a sectional elevation of an air-conditioning apparatus provided with a valve system according to the invention, and

Figure 2 shows a side elevation of the apparatus of Figure 1 showing the control means of the valve system.

Referring to the drawings, there is shown an induction-type air-conditioning apparatus 1 of which one side member 2 is shown in

Figure 2. The apparatus 1 is of an upright rectangular cross-section with a top 3 containing an opening in the form of, for example, a grating 4 or the like through which tempered ventilating air may escape to the space to be air-conditioned. The apparatus 1 has a front panel or panels 5 behind which there is a cooling device 6 consisting, for example, of pipe coils and/or of laminations containing cooling medium. The cooling device 6 and the front panel 5 respectively are in communication with the air surrounding the apparatus 1 through an aperture 7 which is arranged in such a way as to cause inflowing air to pass through the whole of the cooling device 6 when an air passage (described below) is opened. A so-called by-pass aperture 8 is provided in the front panel 5 at a position slightly below (as viewed in Figure 1) the cooling device 6. Finally, the underside of the apparatus 1 contains a heating device 9 consisting of pipe coils and/or fins in which a suitable heating medium circulates or which may be heated by any means. An aperture 10 permitting air to flow into the apparatus and to pass through the heating device 9 to be suitably heated is provided in the underside 11 of the induction apparatus 1. A back panel 12 of the induction apparatus 1 may be completely closed.

A ventilating-air supply duct 13 consisting preferably of a sheet-metal tube having a relatively large diameter of, for example, 100 mm, extends above the heating device 9 in spaced relation thereto. The tube 13 may be mounted to extend between both side members 2 of the induction apparatus 1, and it may contact, for example, the inside surface of the panel 12. One end of the duct 13 is closed, its other end being connected to a source of pressurized ventilation air, e.g. a blower (not shown). At the top (as viewed) the duct 13 is provided, for example, with two rows of nozzles 14 through which the ventilating air is blown out in the direction of the grating 4 to flow into a room containing the apparatus 1. En route to the grating 4, a passage 28 for the ventilating-air is bounded partly by the two side members 2 of the induction apparatus, partly by the panel 12 and partly by a partition 15 extending from the top 3 of the apparatus 1 to a position adjacent the nozzles 14 but preferably, however, slightly above and laterally of the nozzles, that is to say, between the nozzles 14 and the panel 5. In a preferred embodiment, the partition 15 may extend at a slight angle to the vertical, that is at an angle of a few degrees, for example between 1° and 5°. The lower edge 16 of the partition 15 is preferably bent at an angle to the remainder of the partition of, for example, 35° in a direction away from the ventilating-air duct 13, the edge 16 carrying a sealing lip 17 made, for example, of a rubber or rubber-like elastic material which extends beyond the margin of the edge 16.

Instead of the ventilating-air passage 28 being bounded by the panel 12 of the apparatus 1, a baffle 18 made, for example, of foam, cellulose or a fibrous material may be provided (Figure 1). The lower edge of the baffle 18 then engages in the throat between the duct 13 and the panel 12, its opposite edge being adapted to be anchored in the grating 4, one anchored position of the baffle 18 being plane-parallel with the panel 12, another position being that shown in Figure 1, in which the baffle 18 has the effect of reducing the cross-section of the ventilating-air passage 28 continuously in the direction towards the grating 4. The grating 4 consists advantageously of U-shaped rails or bars with downwardly directed arms in one of which the top edge of the baffle 18 may be inserted. It has been found that a baffle 18 of this kind facilitates a degree of control of the ventilating air and, in addition, may serve as a sound-proofing means provided it is made of a fibrous or other material having advantageous sound-absorbing properties.

From Figure 1, it will also be seen that there is a first throttle-valve spindle 19 situated towards the left-hand side of the apparatus 1 and level with the heating device 9 and extending substantially parallel to the longitudinal axis of the duct 13; the spindle 19 carries a first throttle valve or damper 20 which, in one end position, contacts the duct 13 through a sealing lip 21. One half of the sealing lip 21 may be secured to the duct 13 so as to be flush therewith, whilst its other half projects therefrom at a suitable angle of, for example, 45°.

The throttle valve 20 co-operates with a pretensioned torsion spring 22 which is so constructed and arranged that it holds or tends to hold the throttle valve 20 in a first or closed position in which it contacts the lip 21 on the duct 13. A screw-threaded part of the spring 22, by which part it is positively connected to the valve 20, may be provided on a section of the spindle 19 laterally of the valve 20, whilst a stationary projecting end of the spring is anchored in the apparatus 1, for example in a part projecting from the respective side member 2.

In addition to or instead of, the spring 22, the throttle valve 20 may be controlled by a counterweight which is provided on a valve part projecting from the spindle 19, that is to say a part projecting from the spindle 19 as seen from the duct 13 and from the sealing lip 21. The torsion spring 22 may be replaced by a spring of another type, provided the spring, or the counterweight when used, has the same effect namely that of holding or urging the throttle valve or damper in or to the closed position.

Finally, a second throttle valve or damper

25 is provided, at a position generally above the first throttle valve or damper 20, on a second throttle-valve spindle 24 disposed slightly below the cooling device 6. Considered in profile, the two spindles 19 and 24 and the two throttle valves 20 and 25 extend longitudinally in the same direction, namely parallel to the longitudinal axis of the duct 13. The second throttle valve 25 is provided with a pretensioned torsion spring 26 and/or a counterweight 27 and/or another type of spring holding or tending to hold the valve 25 in a first or closed position, in which it contacts the sealing lip 17 as shown in full lines in Figure 1. By "closed position" in this case is meant the closing of the passage through the cooling device to the ventilating-air passage 28, whilst in the case of the first throttle valve 20 the "closed position" designates the closing of the passage through the heating device to the ventilating-air passage 28.

A motor 29 (Figure 2), which may be a pneumatic motor or an electric motor of known construction is provided on the outer side of a side member 2, the motor being controlled by a room thermostat, not shown. The motor 29 may be secured to the side member 2 by means of a bracket 30, and includes a rectilinearly-movable operating member or shaft 31 the free end of which carries a fastening element 32. Two downwardly extending, preferably parallel, connecting rods 33 and 34 are secured to the fastening element 32, the connecting rod 33 being approximately twice as long as the connecting rod 34. The lower ends (as viewed) of the two connecting rods pass respectively through torsion-resistant swivel arms 35 and 36 provided on the throttle-valve spindles 19 and 24, one end of each swivel arm 35 and 36 being thus secured to its respective throttle-valve spindle whilst the other, free end of each swivel arm is provided with a hole through which the respective connecting rod is passed. The connecting rods 33 and 34 are mounted with sliding fit in openings (not shown) of the swivel arms, each connecting rod being, however, provided with a stop 37 or 38, preferably in the form of a sectional deformation or the like. It will be noted that in the fully retracted starting position of the operating member 31 of the motor 29 as shown in Figure 2, the stop 37 of the connecting rod 33 contacts the underside of the swivel arm 35 thus preventing that arm from swivelling in the clockwise (as viewed) direction and the damper 20 is held in its second or open position as shown in full lines in Figure 1. In this condition of the motor 29 the stop 38 of the connecting rod 34 is disposed at a distance above the swivel arm 36 which is thus unaffected by its connecting rod. The connecting rods 33 and 34 may be hinged to the fastening element 32 in order to avoid jamming between the rods and the respective swivel arms. Where a pneumatic motor 29 is used, the room thermostat is connected thereto, for example, by a flexible tube 39. In other cases such as when the motor 29 is an electric motor other suitable connecting means are available for connecting the room thermostat to the motor.

The system hereinbefore described and illustrated in the drawings operates as follows:-

As mentioned above, the motor 29 is controlled by a room thermostat (not shown), it being assumed that the operating member or motor shaft 31 is in its fully retracted position for maximum heating requirements and in the fully extended position for maximum cooling requirements. Adjustment in this respect may be facilitated by a fastening element 32 adjustably secured to the shaft 31 for adjusting the effective distance between the stops 37 and 38 and the motor 29. In the fully retracted position of the shaft 31 the first throttle valve 20 is held by the shaft in a second or open position and the second throttle valve 25 is held by the spring 26 in the first or closed position, indicated by solid lines. In these positions of the valves the free end of the throttle valve 20 is close to or contacts the underside of the second throttle valve 25 and air can pass through the apparatus through the aperture 10 and through the heating device 9 into the ventilating-air passage 28 in which the blown-out ventilating air from the duct 13 produces a suction so that air is drawn in through the aperture 10. The air thus drawn in and heated is ejected through the grating 4 and together with the ventilating air from the duct 13 flows from the grating 4 into the space to be air-conditioned, the air mixture thus obtained having a higher temperature than the ventilating air from the duct 13. In known manner, the nozzles 14 may be of any suitable construction so that they may impart a desired velocity to the air escaping therefrom in order to obtain the desired ratio between the ventilating air escaping from the duct 13 and the air drawn in through the aperture 10 and together therewith. It will also be noted from Figure 1 that in this condition of the apparatus 1 the air paths from both the by-pass opening 8 and from the cooling device 6 are completely blocked. When the room theremostat then transmits an impulse to the motor 29 indicating that heating of the air is not required, the motor shaft begins to extend, the connecting rods 33 and 34 move simultaneously downwards, the connecting rod 34 sliding through the swivel arm 36 without affecting it on account of the lost-motion between the stop 38 and the swivel arm 36, while the swivel arm 35 moves in the clockwise direction and remains in contact with the stop 37 with the result that

the first throttle valve 20 moves to the first or closed position, namely the position in which it contacts the lip 21, since the pretensioned torsion spring 22 moves the valve 20 to the closed position if the stop 37 permits this. In this condition of the apparatus 1, the first throttle valve 20 and the second throttle vale 25 are both closed, that is to say, the heating and cooling devices are both disconnected from the ventilating-air passage 28. However, the ventilating-air passage 28 is in connection with the bypass opening 8 to permit untempered air to be drawn in through the bypass opening 8 and ejected through the grating 4 together with the ventilating air from the duct 13.

When the motor shaft 31 extends further to the fully extended position, the swivel arm 35 is not affected and the first throttle valve 20 remains in its first, closed position, the connecting rod 33 sliding through the arm 35 to provide a lost-motion connection between the arm and the stop 37. However, the stop 38 acts on the swivel arm 36 and the second throttle valve 25 is moved to the open position, namely away from the sealing lip 17, to contact the duct 13 through a sealing lip 40. In this condition of the apparatus 1, the passages through the heating device 9 and thrrough the bypass opening 8 are both blocked, but the passage through the cooling device 6 is open and the air so cooled together with the air from the duct 13 is enected from the grating 4 until another signal is transmitted to the motor 29 from the room thermostat. When cooling of the air is no longer required, the operating member 31 begins to retract so that the second throttle valve 25 closes but the first throttle valve remains closed due to the lost-motion between the stop 37 and the arm 35. Thus, the path from the by-pass opening 8 to the air passage 28 is opened. On continued retraction of the operating member 31, the stop 37 moves the first throttle valve 20 to the open position and the path from the by-pass opening 8 is closed.. In this way the temperature of air leaving the apparatus 1 can be controlled in dependence on the air temperature of the space being air-conditioned.

WHAT WE CLAIM IS:

1. A valve system comprising a first pivotally-mounted throttle-valve or damper and a second pivotally-mounted throttle-valve or damper each biassed by spring means and/or by weight means to a first limit position, and an actuator for moving said first and second throttle-valves or dampers to a second limit position, in which valve system:

the actuator has a rectilinearly-movable operating member connected to a first drive rod for controlling said first throttle-valve or damper and to a second drive rod for controlling said second throttle-valve or damper whereby when said operating member is in its fully retracted position said first throttle-valve or damper is in its second limit position and said second throttle-valve or damper is in its first limit position, and when said operating member is in its fully extended position said first throttle-valve or damper is in its first limit position and said second throttle-valve damper is in its second limit position: and

the first drive rod has a lost-motion driving connection with a first arm rigid with the first throttle-valve or damper and the second drive rod has a lost-motion driving connection with a second arm rigid with the second throttle-valve or damper, whereby in the movement of said operating member in either direction between its fully retracted and fully extended positions there is an intermediate position of the operating member in which both said first and second throttle-valves or dampers are in said first limit position.

2. A valve system, according to Claim 1, in which said first and second drive rods are pivotally connected to said rectilinearly-movable operating member.

3. A valve system, according to Claim 2, in which said first and second drive rods are pivotally connected to said rectilinearly-movable operating member by means of an intermediate member adjustably mounted on said operating member whereby the extent of said lost-motion driving connections between said first and second drive rods and said first and second arms, can be varied.

4. A valve system, according to any preceding claim, in which said first and second throttle-valves or dampers are pivotally-mounted by respective spindles and said spring means comprise, for each throttle-valve or damper, a torsion spring having a part mounted on the associated spindle, the spring acting between the throttle-valve or damper and a stationary fixture.

5. A valve system, according to any preceding claim, in which said lost-motion driving connections are formed by the free passage of said first drive rod through an opening in said first arm and by the free passage of said second drive rod through an opening in said second arm, and by providing a stop on said first and second drive rods for engagement with said first or second arm.

6. A valve system, according to Claim 5, in which the stop on said first drive rod is situated on that side of said first arm further from said actuator and the stop on said second drive rod is situated on that side of said second arm nearer to said actuator.

7. A valve system, according to Claim 6, in which when said rectilinearly-movable operating member is in its fully retracted position the stop on said first drive rod engages said first arm and holds said first throttle-valve damper in second limit position and the stop on said second drive rod is spaced from

said second throttle-valve or damper is held in said first limit position by said spring means and/or by said weight means, and when said operating member is in its fully extended position the stop on said second drive rod engages said second arm and holds said second throttle-valve or damper in said second limit position and the stop on said first drive rod is spaced from said first arm and said first throttle-valve or damper is held in said first limit position by said spring means and/or by said weight means.

8. A valve system, according to any preceding claim, in which said actuator is a pneumatic motor or an electric motor.

9. A valve system constructed and adapted to operate substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawings.

10. A valve system, according to any preceding claim, including a thermostat for controlling said actuator.

11. An induction-type air-conditioning apparatus including a valve system according to Claim 10.

12. Apparatus, according to Claim 11, in which said first limit position of said first and second throttle-valves or dampers is a closed position and said second limit position is an open position.

13. Apparatus, according to Claim 11 or Claim 12, including an air-heating device and an air-cooling device, and in which said first throttle-valve or damper controls the air path through the heating device and said second throttle-valve or damper controls the air path through the cooling device.

14. Apparatus, according to Claim 13, including an air bypass path, and in which said first and second throttle-valves or dampers co-operate with each other so that when said rectilinearly-movable operating member is in said intermediate position the air bypass path is open but when either one of said throttle-valves or dampers is in the open position said air bypass path is closed.

15. An induction-type air-conditioning apparatus according to claim 11 constructed and adapted to operate substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawings.

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2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

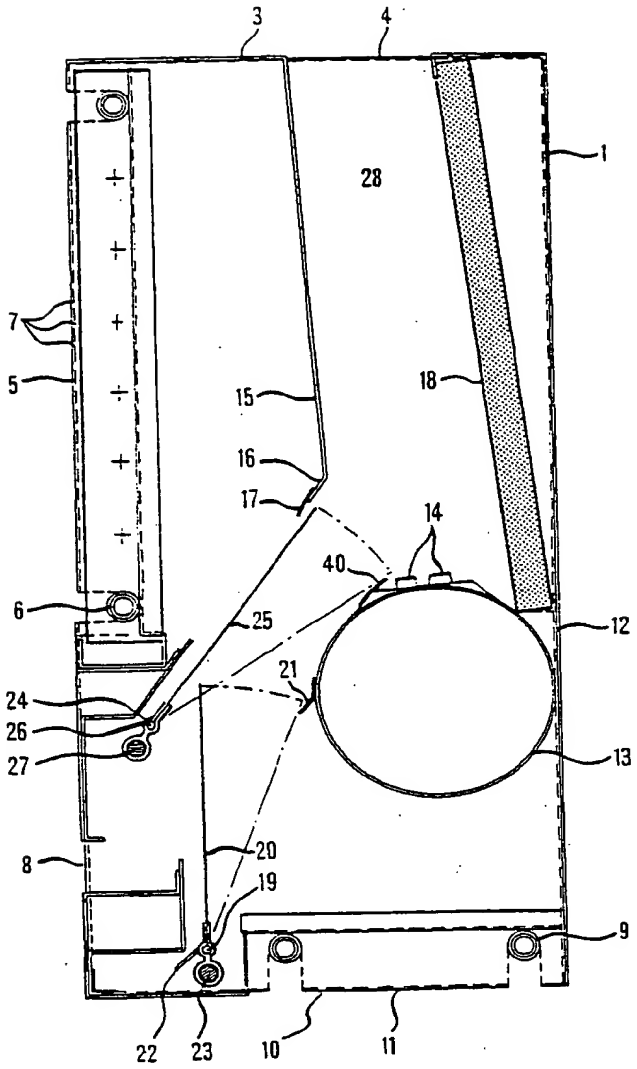

Fig.1

1577039 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

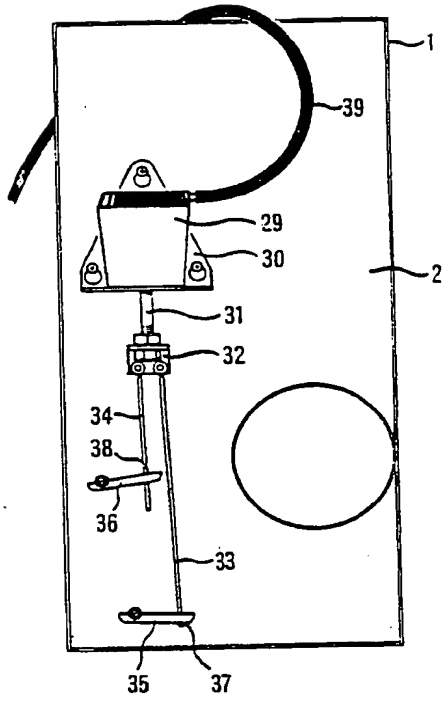

Fig.2